subsequently compressing said conditioned feed material at a compression ratio of at least 4:1 to destructure said fibers; and

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further processing said material including chemical digestion to form a lignocellulose pulp. --

Remarks

As a result of the foregoing amendment, applicant now presents four independent claims, namely, numbers 1, 28, 29 and 30 and associated dependent claims 2, 3, 5, 7, and 23-27.

The specification has been amended to clarify a paragraph on page 12, by substituting a new paragraph, the content of which is supported in part by the deleted paragraph and in part by the self-evident conformance with the disclosure of Figures 1, 2 and 3 and associated original text. The other amendments correct typographical errors.

p.3 10-100 psi

Claim 1 is an amended version of original independent claim 1, containing additional limitations to the effect that the conditioning of the material occurs in an environment of saturated steam at a pressure of at least 10 psi, and that the subsequent compression occurs in an environment of saturated steam at a pressure of at least 10 psi to destructure the fibers without significant breakage across grain boundaries. The environmental conditions in claim 1 are supported in the specification on page 3, lines 13-22 and page 4, lines 11-27. The feature whereby the environment of temperature and pressure at saturated conditions in the compression device, is in the same range (or is substantially the same) as that in the conditioning

chamber, is supported, for example, on page 2, line 22 and page 15, beginning at line 9. The term "destructuring" and the minimization of breakage across the grain boundaries, is supported in the specification in the paragraph beginning on page 2 line 29 and extending through page 3, line 12. The recitation that the step of compressing is performed directly after the step of conditioning, is supported on page 15, beginning at line 9.

New independent claim 28 specifies a more restrictive environment than claim 1. The pressure range of 30-100 psi is within the range of 25 -100 psi disclosed on page 4, line 10.

Independent claim 29 is more specifically directed to a method for producing thermo-mechanical pulp. The conditioning is specified as provided in an environment of saturated steam at a pressure in the range of about 10-25 psi, with subsequent compression in an environment of saturated steam at a pressure in the range of about 15-25 psi at a compression ratio of at least about 4:1 to destructure the fibers. This range is supported on page 3, line 25.

Finally, independent claim 30 is directed to a method for producing chemical pulp, wherein the conditioning step is performed in a steam environment at a temperature of at least 120°C and the corresponding saturation pressure, followed by compression at a ratio of at least 4:1 to destructure the fibers. Support for the temperature recitation can be found on page 4, line 5.

Before turning to the content of the Official Action, applicant wishes to emphasize the general concept of the invention. The invention is directed to what can be characterized as a pre-processing or pre-treatment at the upstream end of a

mechanical or chemical process for producing pulp from lignocellulose fiber containing feed material, particularly wood chips. According to applicant's invention, the feed material is (1) first conditioned in an environment of elevated temperature and pressure, (2) then compressed in an environment of elevated temperature and pressure, at a higher than conventional compression ratio, to partially separate, i.e., destructure the fibers, (3) followed by further processing either mechanically or chemically, to produce pulp. The conditioning at elevated temperature and pressure and compression at elevated temperature and pressure produce a synergistic effect such that the fibers, although destructured, remain pliable, i.e., they do not become so friable as to crumble when rubbed between the thumb and forefinger. It is the destructuring without significant breakage across grain boundaries, which maintains the pliability and provides significant advantages relative to what is disclosed or taught by the prior art.

In the context of mechanical refining, in particular TMP production, the invention would be utilized upstream of the conventional pre-steaming vessel, from which pre-steamed chips are fed into the refiner *per se*. For example, in applicant's Figure 1, the inventive pre-treatment is embodied in the combination of components 3 and 6, which are upstream of the preheating components 20,22 and the refiner components 30,32. Similarly in Figure 2, the inventive pre-treatment is embodied primarily in the components 52 and 6, which are upstream of the preheating components 20,22 and refiner components 30,32. In the embodiments of Figures 1 and 2, the pre-treated material is temporarily stored in a bin under atmospheric pressure, before being conveyed to the preheating components. The embodiment

depicted in Figure 3 likewise shows the inventive pre-treatment embodied primarily in components 74,80, upstream of the pre-heating components 20,22 and refiner components 30,32, with direct discharge from the pre-treating components to the pre-heating components.

Particularly in the combination with the so-called RTS-TMP process according to which the preheating of the feed material in components 20,22 is performed at a temperature above T_g, for a short time period of e.g., under 30 seconds, before direct introduction into a high speed disc refiner 32, applicant's invention has shown significant energy improvement without loss of quality.

In the realm of chemical pulping, pulp is produced by a digestion process which may or may not be followed by disc refining. Applicant's pre-treatment is performed upstream of the digestion process in conjunction with preheating the chips prior to introduction into the digester.

Applicant has cancelled a number of original dependent claims, and has substituted a number of new claims, some of which more specifically recite the invention in the context of either thermo-mechanical refining or chemical pulping. For example, amended claim 3 specifically recites the further steps of pre-heating the destructured material and conveying the pre-heated destructed material to the inlet of a primary disc refiner. In this manner, the conditioning and destructuring steps recited in claim 1, cannot be considered as reading on any equipment which pre-heats and feeds chips immediately upstream of a disc refiner. Moreover, claim 23, which further modifies claim 3, corresponds to the embodiments shown in Figures 1 and 2, where pressure barriers are formed substantially at 11 and 19, whereby the conveyor 13,

storage bin 14, and plug screw feeder 15 are isolated at substantially atmospheric pressure, whereas the conditioning and compression steps such as performed in components 3 and 6, and the pre-heating such as performed in components 20 and 22, are performed at a higher pressure. This is another way in which applicant's invention is distinguishable from the ordinary upstream processing associated with TMP refining.

New claim 26 further modifies claim 3, in specifying a relatively low temperature maximum of about 120°C for the conditioning and compression steps, associated with a thermo-mechanical refining process. This is typical of the glass transition temperature for lignin. Furthermore, in the mechanical refining realm, a relatively short time interval of conditioning, such as 3-60 seconds would be used as supported on page 3, line 21 of applicant's specification.

Similarly, with respect to amended claim 5, the preferred RTS-TMP process is incorporated to some extent into the claim, by the recitation of the specific steps of preheating the destructured material in an environment of saturated steam at a pressure above the glass transition temperature for a period of time of less than 30 seconds; conveying the pre-heated and destructured material to the inlet of a primary disc refiner, followed by high speed refining of the material. Claim 24 is an analog to claim 23, in requiring that the discharge of the conditioning and compressing step go into atmospheric conveying and storage, prior to the step of pre-heating immediately before introduction into the refiner.

Turning now to the substance of the Official Action, the examiner rejected claims 1-14 under 35 U.S.C. §102(b) as anticipated by, or in the alternative under 35

U.S.C. 103(a) as obvious over U.S. Patent 4,869,783 (Prusas) with or without the disclosure of the paper to Lunan or the application PCT96/41914. Prusas relates to chemical pulping, whereas Lunan and PCT96/41914 relate to disc refining. Applicant believes that none of these references, any of the other references of record, or the documents brought to the attention of the examiner as set forth below, taken alone or in combination, teach or suggest applicant's claimed invention.

Prusas is directed to a chemical pulping configuration as depicted in Figure 4 thereof, which shows wood chips fed at atmospheric conditions from a hopper 10 into a screw press 12 equipped with a plug former for applying a back pressure to the chips as they pass through the press. The press 12 destructures the chips as a result of compression in the ratio of 3/1 to 5/1. The destructured chips are then fed directly into the compartment 16 of a continuous vapor phase digester, whereupon they are conveyed into the main digester tank 20 by feedscrew 22. Because the chips are not completely defiberized when they leave the digester, the material is blown from the digester 18 into a disc refiner. The resulting pulp is washed and is further processed in, e.g., an oxygen delignification and bleaching plant (see Prusas col. 8, lines 1-30).

Although Prusas indicates in column 4 beginning at line 41 that it is desirable to expose the chips to steam before destructuring in the screw press 12, Prusas does not specify the steaming conditions. The most common steaming conditions are at or slightly above atmospheric, for an extended period of time, i.e., many minutes. The cited passage also indicates the desirability of operating the screw press or other destructuring means at a temperature above 100°C, such as 120°C - 160°C. Although an elevated temperature is disclosed, Prusas does not specifically disclose

that the screw press environment is at saturated steam conditions, with a high pressure corresponding to the elevated temperature.

Importantly, Prusas does not disclose, suggest or imply that the pre-steaming of the chips should be performed at elevated temperature and pressure conditions, or even at the same environment as in the screw press. Moreover, Prusas performed a number of experiments and stated at col.4, line 50 that,

> "Chips pre-treated in accordance with the present invention are friable. That is, they can be crumbled by pressing and rolling the chip between the thumb and index finger."

Prusas goes on to state in col.8 beginning at line 31,

> "The partially defibered chips appear to be more susceptible to high temperature, than a less destructured chip. As such, it is desired to use milder cooking temperatures in the present invention."

Finally, in col. 9, beginning at line 42, Prusas states that,

> "Strength properties approach those of conventionally cooked pulp when the cook is terminated at kappa number of 64 but are lower by 12-27% when the cooking proceeded to kappa number of 27.4."

Thus, Prusas did not fully appreciate that the friable destructured chip was a major factor in the degradation at high cooking temperature and the limitation on the extent of cooking as represented by the claimed kappa range of 45 to 70.

In contrast, with applicant's combination of conditioning the chips at elevated temperature and pressure, followed by compressive destructuring at a high

compression ratio in the range of 4/1 to 8/1, an ideal combination of a high degree of fiber separation yet maintenance of the pliability of the fibers, produces higher yields and accommodation of higher temperature and lower kappa cooking conditions. The high yield is a result of applicant's destructuring of the fibers without significant breakage across grain boundaries. Such breakage occurs in Prusas and produces a high fines content which is essentially a loss factor in the cooking. Furthermore, applicant's process retains a higher proportion of long fibers which produces improved strength at the same cooking conditions as Prusas.

Applicant emphasizes that the specification supports the distinction recited in independent claims 1 and 28, to the effect that the fibers are destructed without significant breakage across grain boundaries. Figure 12 is an electron photomicrograph of a woodchip which has not been conditioned, compressed or otherwise pre-treated. The rigid fiber structure is intact, and there is a lack of separation of the individual softwood fibers along their longitudinal axis. Figure 13 is an electron photomicrograph of a woodchip conditioned and compressed according to the present invention, wherein the chip was exposed to steam heating and pressurization at 22 psi, followed by high compression at 5:1 compression ratio. The micrograph shows a high level of axial separation along the longitudinal axis of the individual softwood fibers. Some surface delamination is also in evidence. Figure 14 is an electron photomicrograph of a woodchip which has been atmospherically pre-steamed, then compressed at a 4:1 compression ratio. A high level of axial separation of fibers is noted in this micrograph, but this is tempered by the large number of fractured fibers. The presence of fibers sheared in the compression step is also noted.

Some sheared fibers appear in the lower central region of the micrograph. They are identified by the somewhat flattened "O" shape of the sheared end of the fiber.

Figure 14 represents the type of destructured chip which results from the high compression of atmospherically pre-steamed chips as described in the Prusas patent and the nature of the resulting partially destructured chip is consistent with the description of Prusas quoted above. In contrast, Figure 13 which reflects a woodchip conditioned at elevated pressure and temperature before destructuring to an even higher compression ratio than that associated with Figure 14, shows the superiority of destructuring without significant breakage across grain boundaries, relative to what one of ordinary skill would derive from Prusas. For this reason, claims 1, 28 and 30, which read on a chemical digestion pulping process distinguish over Prusas, whether taken alone or in the combination cited by the examiner.

Furthermore, applicant provides several examples of the improved performance of TMP and RTS-TMP depending on the use of chips processed according to the invention. In Example 1, woodchips were pre-treated according to the invention as subjected to a saturated steam atmosphere at 22 psi at 128°C for a period of six seconds, then subjected to compression at a ratio of 5/1. The woodchips were fed to a pressurized single disc refiner operating under RTS conditions. In Comparative Example 1, the woodchips were exposed to steam under ambient conditions for a period of 25 minutes, then compressed at a ratio of 4:1. In Comparative Example 2, there was no pre-treatment. As shown in Table A, the performance of Example 1, demonstrates improved strength properties and a significant reduction in the specific energy required to produce pulp of the same freeness.

Beneficial results are also available in connection with digestion processes. With reference to Tables D and E of applicant's specification a comparison is made of Kraft pulping processes in which the woodchips of Comparative Example 6 were subjected to a conditioning treatment consisting of atmospheric steaming and 4:1 compression, but the woodchips of Comparative Example F received no pre-treatment or compression. It was noted that compression of the atmospherically steamed woodchips exhibited shortened fiber length and a high level of finds due to fiber breakage upon compression. In Table E, the woodchips of Example A were subjected to conditioning treatment and compression according to the invention, whereas Comparative Example A received no pre-treatment or compressing. Both were processed to pulp using a Kraft pulping process including a rise to temperature of 1.5 hours and cooking temperature of 170°C. The results indicates similar pulp strength properties in both the condition and compressed pulp example and the unpre-treated sample. This similarity suggests that no damage to the wood fibers occurred in the compression step, due most likely to the prior conditioning step of saturated heat and pressure.

Applicant recognizes that, for example as disclosed in U.S. Patent 5,622,598 (Prough) the pre-steaming of chips for delivery into a digestion system, could be performed at, e.g., 2 bar (see col. 5, line 5). However, Prough does not disclose any form of compression or destructuring between the pre-steaming vessel 42 and the pump 53 or high pressure feeder 30 to the digester.

Applicant submits that one of ordinary skill in the art, even if familiar with the overall system described in Prough, would not recognize the advantage of using the

combination of elevated temperature and pressure for steaming the chips prior to introduction into a compressive destructuring device at elevated temperature and pressure. Moreover, applicant does not concede but for purposes of argument will postulate that even if one of ordinary skill in the field of chemical pulping, contemplated the incorporation of the destructuring device of Prusas into the system of Prough, the chips would be conditioned in a conventional pre-steaming vessel such as 42 operated at no more than about 2 bar (less than 30 psi), rather than in a dedicated conditioning chamber intimately associated with a compression device, operated at a temperature above 120°C and/or pressure above 30 psi. This is covered by applicant's claims 28 and 30.

There is simply no basis for the examiner to attempt to modify Prusas with the disclosure of Lunan or PCT96/41914 because the latter references relate to <u>pre-heating</u> of the chip material prior to introduction directly into a <u>disc refiner</u>. Pre-heating (e.g., as in 20,22 of applicant's Figure 1) is different from and performed following applicant's claimed pre-treatment. In those references (as with applicant's preferred TMP and RTS-TMP), the high pressure is the same as that which occurs in the device which achieves the pulping, i.e., the refiner. In chemical pulping, the pre-steaming is never directly exposed to the high pressure and temperature conditions of the pulping device, i.e., digester, and it is improper for the examiner to select a characteristic inherent to mechanical refining and arbitrarily attribute a similar characteristic for a non-analogous component or function in a chemical pulping process.

Applicant also encloses proposed formal drawings, where the reference numeral "1" has been added in Figure 1 in red. Upon approval, formal drawings will be filed with the Official Draftsman.

For the foregoing reasons, applicant requests reconsideration and allowance of all claims as amended.

Respectfully submitted,

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